CIRCULAR No. 13 NOVEMBER, 1927
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

CURING AND PRESERVING CITRON

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INTRODUCTION

The citron (*Citrus medica* Linn.) was the first of the citrus fruits to be introduced into the Mediterranean region from the Orient and was cultivated there for centuries before the orange and the lemon were known in that region. It is still an important fruit in the countries bordering on the Mediterranean, though its culture has never attained commercial importance in the New World. A small orchard planting in southern California has been fruiting for about 15 years, but its culture has not been extended. Most of the fruiting trees in Florida are specimen trees occurring singly in variety collections or as dooryard trees, many of them top-worked on old orange, grapefruit, or lemon trees.

Recently several small orchard plantings of citron have been made in Florida with the view to supplying at least a part of the fruit now imported into the United States for preserving. These plantings will not come into bearing, however, for several years, and from an economic standpoint citron growing in the United States must be regarded as still in the experimental stage.

The citron roots readily from cuttings and is often propagated in this way in the Mediterranean countries. It is, however, preferably budded on other stocks, such as sour orange, sweet orange, or rough lemon, and does not appear to be restricted to any particular stock. The tree is naturally of drooping habits, and unless pruned to an upright form the lower branches will trail on the ground, where they often take root, forming in time a veritable thicket.

The citron of commerce produces a large, rounded, oblong fruit of handsome appearance and delicious fragrance when ripe, but entirely unfit for food in its natural state. In general appearance the fruit resembles a giant lemon. (Figs. 1 and 2.)

There is a small form of the citron, known as the etrog, cultivated chiefly on the island of Corfu, where it is grown solely for use by the

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Jewish people in the religious ceremonies connected with the Feast of Tabernacles. It is about the size of an ordinary lemon, and a perfect specimen for ceremonial use has the style persistent.[1]

There is in common cultivation a small melonlike fruit which is also known as citron. This grows on a vine and is a type of melon. Its rind is used for preserves; but it should not be confused with the true citron, which is an entirely different fruit.

Large quantities of citron (more than 3,000,000 pounds in 1925) are imported into the United States every year. Most of this comes from Mediterranean countries, with smaller quantities from Porto Rico, Bermuda, and China. About one-half of this citron is

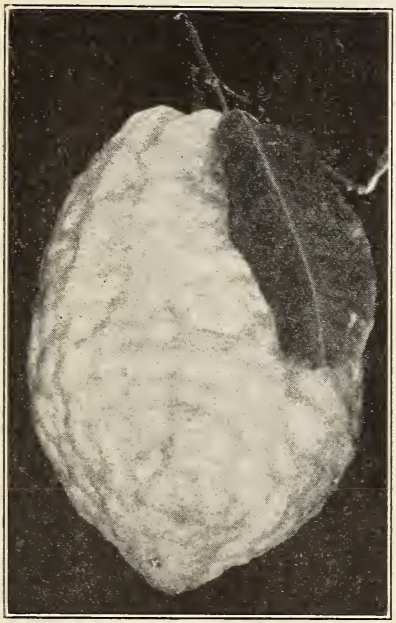

FIG. 1.—Citron fruit (one-third natural size)

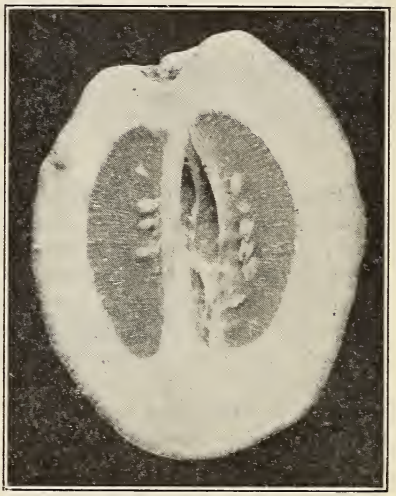

FIG. 2.—Cut citron (one-third natural size)

candied, ready for use. The other half is held in brine, and the sugar preserving of this part is done in this country.

At one time or another articles on the preparation of citron have appeared in various publications. These articles are not generally available, and the directions given are not always clear or sufficiently detailed. The most complete description of the treatment of citron is that by two French investigators, Hollande and Chadefaux.[2] They describe the citron industry as they observed it in Corsica, where they found most of the crop being gathered from October to January. The citrons are taken to the seaports, washed, cut longitudinally into two pieces—the seeds and pulp being removed from the best fruits but not from the poor qualities—and then placed in casks full of sea water. The Mediterranean water contains from 3.7 to 4 per cent of

[1] Preceding paragraphs by T. Ralph Robinson, Office of Crop Physiology and Breeding, Bureau of Plant Industry.

[2] HOLLANDE, A. C., and CHADEFAUX, S. ÉTUDE BACTÉRIOLOGIQUE DE LA FERMENTATION EN EAU DE MER DES CÉDRATS DE CORSE DESTINÉS À LA CONFISERIE. Bul. Sci. Pharmacol. 31 : 458–471, illus. 1924.

CHADEFAUX, S. LA FERMENTATION DES CÉDRATS. Rev. Hort. Algérie 28 : 214–221. 1924.

salt. The citrons remain in the sea water about 40 days, the water being changed on the fifteenth day. During this time there is rather active fermentation with escape of carbonic-acid gas. When the citron rinds have become transparent and the bitterness has disappeared, the curing is considered complete. To end the fermentation, considerable salt (7 to 10 per cent) is added to the sea water.

In this brine the citrons are shipped to factories for the candying process. Hollande and Chadefaux found that the fermentation was caused by the action of yeasts and bacteria. After considerable study and experimenting they determined that a yeast, *Saccharomyces citri medicae* n. sp., and a bacillus, *Bacillus citri medicae* n. sp., were the active and essential agents in the proper curing of the citrons. These two workers found yeast and bacteria in the curing brines and considered these organisms essential to the proper curing of the citron.

Some experiments have recently been made by the Department of Agriculture in curing and preserving citron. The investigations are not yet complete, and the results of even the most successful experiments are not perfect; but a publication of the methods which seem most promising may be useful to those interested in citron-preserving methods.

Some of the fruits used in these experiments came from Florida; others from California and Porto Rico. The considerable differences in size, shape, character of surface, degree of acidity, and bitterness indicate that these fruits were of different varieties or strains. Just which sort is best for preserving is still a question. In the experiments made by the department the citrons with sour pulp and bitter rinds made the best preserves.

SELECTING THE FRUIT FOR PRESERVING

The ability to select citrons for preserving requires some experience and practice. The fruit should be picked when full grown but still green in color. It should be green, not only that the final product may have the greenish tinge demanded by most consumers but also that a tender texture and full flavor may result. With increasing maturity the fibers in the rind become harder and the epidermis (outer skin) becomes tough. A well-ripened, yellow citron has a rich, agreeable aroma, but when preserved it has less flavor than a fruit picked green. Not only size and color but also the texture of the surface and the density of the fruit should be considered, and the oil sacs should be well developed rather than small and crowded, as they are on immature fruit. A certain oiliness of the surface is one indication of proper condition. The full-grown fruits are less dense than the immature. With one exception, all the published articles so far found on the subject recommend green fruit, and in this one case it is not clear whether the writer means entirely ripe and yellow or merely full-grown fruit.

For home use fruit of any size or shape may be used. For commercial purposes, however, uniform size and shape are desirable. Fruits 5 or 6 inches long and 3 or 4 inches in diameter are the usual commercial sizes.

METHODS OF CURING CITRON

Clean the surface, wash, and scrub if necessary to remove scales, corky layers, or other imperfections, and cut in halves lengthwise. Seeds and pulp may remain during the brining process, but as they are often bitter they should preferably be removed. The pulp is rather difficult to remove from either fresh or brined citron, but after cooking it is easily separated from the rind. Experiments do not indicate that the pulp influences the curing process; still it is possible that the dextrose in the pulp may aid fermentation.

The citrons should be put into the brine very shortly after removal from the trees. They ripen rapidly, and the yellow color tends to develop even after the fruit is in the brine. The pieces should be kept entirely submerged. Any weight such as is used for pickles is suitable for this purpose. The containers for brine and fruits may be wood, crockery, or glass.

Clean sea water may be used for the brine, but there are difficulties in obtaining really clean sea water. That used successfully in the Mediterranean countries probably contains as many or more contaminating organisms than any about American shores, so one need not hesitate to use sea water unless it is suspected of heavy contamination. Even in this state it could be boiled before using. If sea water is not available, however, a substitute may be used.

Average sea water contains in 1 liter:

	Grams
Sodium chloride	27.06
Potassium chloride	.76
Magnesium chloride	3.67
Magnesium sulphate	2.29
Calcium sulphate	1.40

Several other salts in smaller quantities.

The density or saltness of sea water varies considerably, owing to inflowing fresh water, evaporation, etc. The average proportion of salts is 3 to 3.5 per cent. The magnesium and calcium sulphates add to the bitterness of sea water, and these are accordingly omitted from the sea-water substitutes made and used in these experiments. It remains to be proved that it is best to eliminate these ingredients.

For a homemade brine the following would be suitable in cool weather: Sodium chloride, 4½ ounces (135 gm.), or about one-fourth pound; potassium chloride, one-ninth ounce (3.42 gm.), or moderately heaped teaspoonful; magnesium chloride, one-half ounce (16.47 gm.), or 2½ moderately heaped teaspoonfuls (the crystallized salt is very deliquescent); water, 1 gallon (about 4½ liters). There is not enough salt in this brine or in sea water to keep the citron from rotting at temperatures of 70° to 80° F. At high temperatures as much as 7 to 10 per cent (10 to 15 ounces of salt to a gallon of water) is needed for this purpose.

Sea salt may be purchased and 4 to 6 ounces used to each gallon of water. Ordinary coarse salt, such as "ice-cream" salt, may be used, 4 to 6 ounces to a gallon of water. The fermentation seems to be less in this plain salt water than in either sea water or sea-water substitute. This lack of activity may be due to other causes.

In the brine the citron rinds pass through a chemical process, a sort of fermentation, which changes or destroys the strong bitter principle. The dense, opaque tissues expand considerably and be-

come entirely translucent. There is usually a vigorous growth of yeast, which clouds the brine and forms a scum over the surface. At favorable temperatures there is considerable formation of gas. According to Hollande and Chadefaux, the prevailing temperature at Bastia, Corsica, in November and December, the months when most of the citron crop is treated, varies from 13° to 16° C. (56° to 60° F.) in the shade, in the day, and is about 10° C. (50° F.) at night.

The desired result in curing or pickling citron is to obtain a firm yet tender rind, with the bitter flavor removed and the agreeable citron flavor retained. All this may be achieved perhaps in other ways, but the sea-water process has been used for a long time with success. It seems probable that some commercial firms steam or boil the fruit and then use a strong brine as a preservative.

The length of time required for the curing varies with the size of the pieces of citron, the degree of maturity of the fruit, and the temperature. A number of unsuccessful experiments have been made in an effort to reduce the time required for curing. Too short a period in the brine produces a preserve bitter in flavor and hard in texture. For halves or quarters of green but full-grown fruit 14 to 16 days is perhaps the shortest curing period advisable. Often 30 or more days are necessary.

If there is vigorous growth and gas formation the brine should be changed about the fifteenth day, if it is necessary to continue curing. When the pieces are cured, they may be used at once for preserving or may be left in the brine until a more convenient time. Brine used as a preservative should contain 6 to 10 per cent of salt. At any stage use only sufficient salt to prevent spoiling, as an excess tends to extract flavor and to toughen the citron.

METHODS OF PRESERVING CITRON

To preserve citrons, transfer the cut halves from the brine to fresh water. Remove the pulp. If the citron has been in sea water or a 3 to 4 per cent brine, no particular freshening is necessary, but if it is taken from stronger brine, keep the citron in flowing or frequently changed water until it is sufficiently freshened. Do not remove all the salt; a small quantity improves the flavor. Cover the fruit with water and boil gently or steam until a needle or a straw will penetrate the rinds fairly easily. (In the department experiments the steamed fruit retained less flavor than the boiled.) Then put into cold water for 8 to 24 hours to restore the crispness, which is much reduced by the cooking. Crisping is followed by the sugar preserving. This process of filling the tissues with sugar can be varied considerably. Begin with a thin sirup, and gradually increase its density. (See Table 1.) The rapidity of passage from sirup to sirup depends somewhat on the size of the pieces and the temperatures maintained. By using more heat the preserving process can be shortened, but the product will be darker in color and less delicate in flavor. Slower processes in which little or no heat is used are tedious but more likely to result in fine quality.

A good grade of sugar (saccharose) is probably best for making the sirups, but glucose can be used. Glucose alone or in part could be used for the first sirups, larger proportions of cane sugar being

added toward the end. The white corn sirup sold in cans is a good and convenient form of glucose. After the citron has been 24 hours in the first sirup, taste to see if enough salt has been removed. If too salty, this sirup should be discarded. Do not make separate lots of sirup; merely add sugar or heavy sirup to increase the density of the one previously used.

TABLE 1.—*Equivalent values of Brix, Baumé, and specific gravity within the range used in citron preserving*

Degree Brix (percentage by weight of sucrose)[1]	Specific gravity	Degree Baumé	Degree Brix (percentage by weight of sucrose)[1]	Specific gravity	Degree Baumé	Degree Brix (percentage by weight of sucrose)[1]	Specific gravity	Degree Baumé
5	1.01970	2.8	35	1.15411	19.6	70	1.35088	38.1
10	1.04014	5.7	40	1.17943	22.3	74	1.37639	40.1
12	1.04852	6.8	45	1.20565	25.0	76	1.38939	41.1
15	1.06133	8.5	50	1.23278	27.7	78	1.40254	42.1
18	1.07441	10.1	55	1.26086	30.4	80	1.41586	43.1
20	1.08329	11.3	60	1.28989	33.0	84	1.44298	45.1
25	1.10607	14.1	65	1.31989	35.6	85	1.44986	45.5
30	1.12967	16.8	68	1.33836	37.1	90	1.48486	47.9

[1] Saccharose, cane sugar.

For an average extended process, start with a sirup of 18° Brix (specific gravity 1.074, sugar 18 parts by weight with 82 parts by weight of water). Keep the sirup containing the citron at nearly the boiling point for 15 minutes. When the citron is heated in the sirup numerous white opaque areas develop, but these disappear on cooling. On each succeeding day add enough sugar or thick sirup to increase the density by 3° to 4°, each time heating the sirup and pouring it over the citron, or gently heating the citron in the sirup. After 20 days the sirup should be 80° to 84° Brix and very thick when cold. More than 24 hours between changes, especially in the last heavy sirups, are advisable. If a gentle warmth, 100° to 110° F., can be maintained, the sugar penetration is hastened. The last sirup will be so thick that unless heated it is difficult to remove the pieces of citron. Drain the citron on a wire rack. Excess sirup may be washed off by dipping the pieces quickly in and out of hot water. Wipe them dry with a cloth and keep them in hot sunshine or in *a cool oven* until the surface remains dry.

SHORTER PRESERVING PROCESSES

Shorter preserving processes that gave fair results are as follows: Boil the citrons gently in 20° Brix (specific gravity 1.08329) sirup for 15 minutes. Two days later add sugar to bring the sirup to 30° Brix (specific gravity 1.12967). Boil gently for 15 minutes. Repeat this for five successive days, increasing the density of the sirup to 45, 55, 68, 78, and 84° Brix (specific gravity 1.2056, 1.26086, 1.33836, 1.40254, 1.44298). Then remove, drain or wash, and dry for three to five days.

Using small pieces (rinds cut into quarters or eighths), a density of even 40° Brix may be used for a first sirup, changing in 24 or 48 hours to 55°, then 60°, and finally 65°. This citron should be kept in the last sirup until needed for use, or else heavily glacéd, as it dries out readily.

For a very short process, the rinds are cut into small pieces, not more than an inch thick, and put into 4 to 5 per cent salt water for 24 hours. Then drain the fruit, put it into cold water, and bring to a boil. Change the water and repeat the boiling until oil has been removed sufficiently to render the fruit palatable. Then boil or steam until the citron is tender. Drain and put into a sirup made of 1 pound of sugar and 1 pound of water to each pound of fruit. Boil for half an hour, pour into jars, and seal. Remove and drain as needed.

If desired, the citron may be glacéd after removal from the last sirup. Glacéing is not necessary. Well-prepared citron is firm and dry and keeps well without any protective covering, and unless very well done the glacéing does not improve its appearance. Many

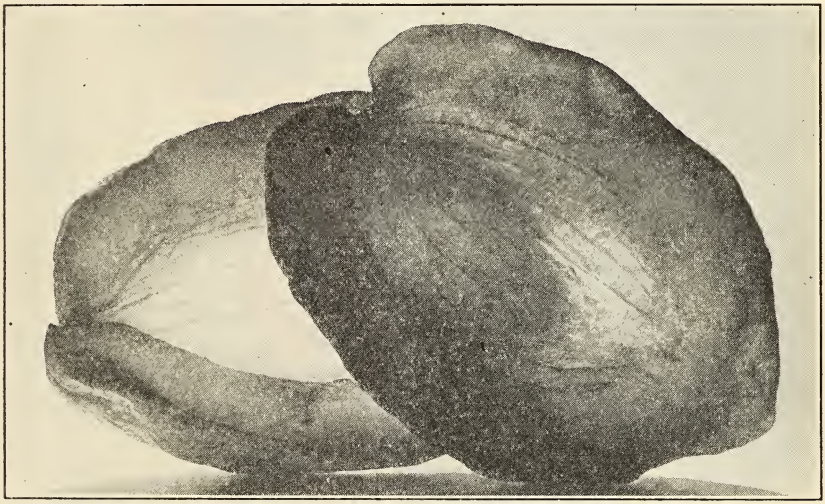

FIG. 3.—Preserved citron, drained (three-fifths natural size)

dealers prefer what is known as drained citron, which is the citron just as removed from the last sirup. (Fig. 3.)

If the citron lacks flavor, as much of it does, either because of poor variety or from being too ripe, the addition of a few fresh leaves of orange or lemon to the sirup will impart an agreeable flavor.

DETERMINING DENSITY OF SIRUP

It is easy to make sirups of any required density according to the Brix scale. Take of sugar, by weight, a quantity equal to the degree desired, and add sufficient water, by weight, to bring the number to 100. For example, for a sirup that will be 20° Brix, use 20 parts of sugar and 80 parts of water; for a sirup of 84°, use 84 parts of sugar and 16 parts of water.

It is not necessary to discard the used sirups and make up a new one for each different sirup required. Add sugar to increase the density. The density or thickness should be increased gradually, and adding sugar by guess is an unsatisfactory method. The used

sirup is not as thick as when made, as it has absorbed water from the fruit. After 24 hours the 18° Brix may be only 10°, so it is impossible to know how much sugar needs to be added to bring the sirup up to a certain density.

It is simpler and more economical to have an instrument with which to determine density. A sugar hydrometer may be purchased for $1.50 and a tall slender glass cylinder for less. (Brix hydrometers usually have a short scale range which for this work would require several hydrometers having different ranges. There are hydrometers with the Baumé scale 0° to 70° and specific gravity scales 1.000 to 2.000 range. These can be purchased for $1.) The spindle is suspended in the cylinder full of sirup, and the scale readings indicate the density. Then sugar or thick sirup can be added until the required density is reached.

If one must guess, it is safer to use too little sugar than too much, but it lengthens the process.

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